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Digital Diagnostic Monitoring Interface for Optical Transceivers

Revision 9.4

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9.4- (C)	Add extensions to include additional technologies. Results of Dec. 5 03 discussions. Includes: Support for Multiple Application Selection Reserved values for SFF-8079 in Table 3.1, Table 3.10, Table 3.12, and Table 3.17. Additional transceiver type values in table 3.5 Additional values in table 3.5a Additional values in table 3.12	1/29/04

1. Scope and Overview

This document defines an enhanced digital diagnostic monitoring interface for optical transceivers that allows real time access to device operating parameters. It also adds new options to the previously defined serial ID memory map that accommodate new transceiver types that were not considered in the SFP MSA or GBIC documents.

The interface is an extension of the serial ID interface defined in the GBIC specification as well as the SFP MSA. Both specifications define a 256 byte memory map in EEPROM which is accessible over a 2 wire serial interface at the 8 bit address 1010000X (A0h). The digital diagnostic monitoring interface makes use of the 8 bit address 1010001X (A2h), so the originally defined serial ID memory map remains unchanged. The interface is backward compatible with both the GBIC specification and the SFP MSA.

2. Applicable Documents

Gigabit Interface Converter (GBIC). SFF document number: SFF-0053, rev. 5.5, September 27, 2000.

Small Form Factor Pluggable (SFP) Transceiver MultiSource Agreement (MSA), September 14, 2000.

SFP Rate and Application Selection. SFF document number SFF-8079, rev TBD, Date TBD

SFP Rate and Application Selection Values. SFF document number SFF-8089, rev TBD, Date TBD

3. Enhanced Digital Diagnostic Interface Definition

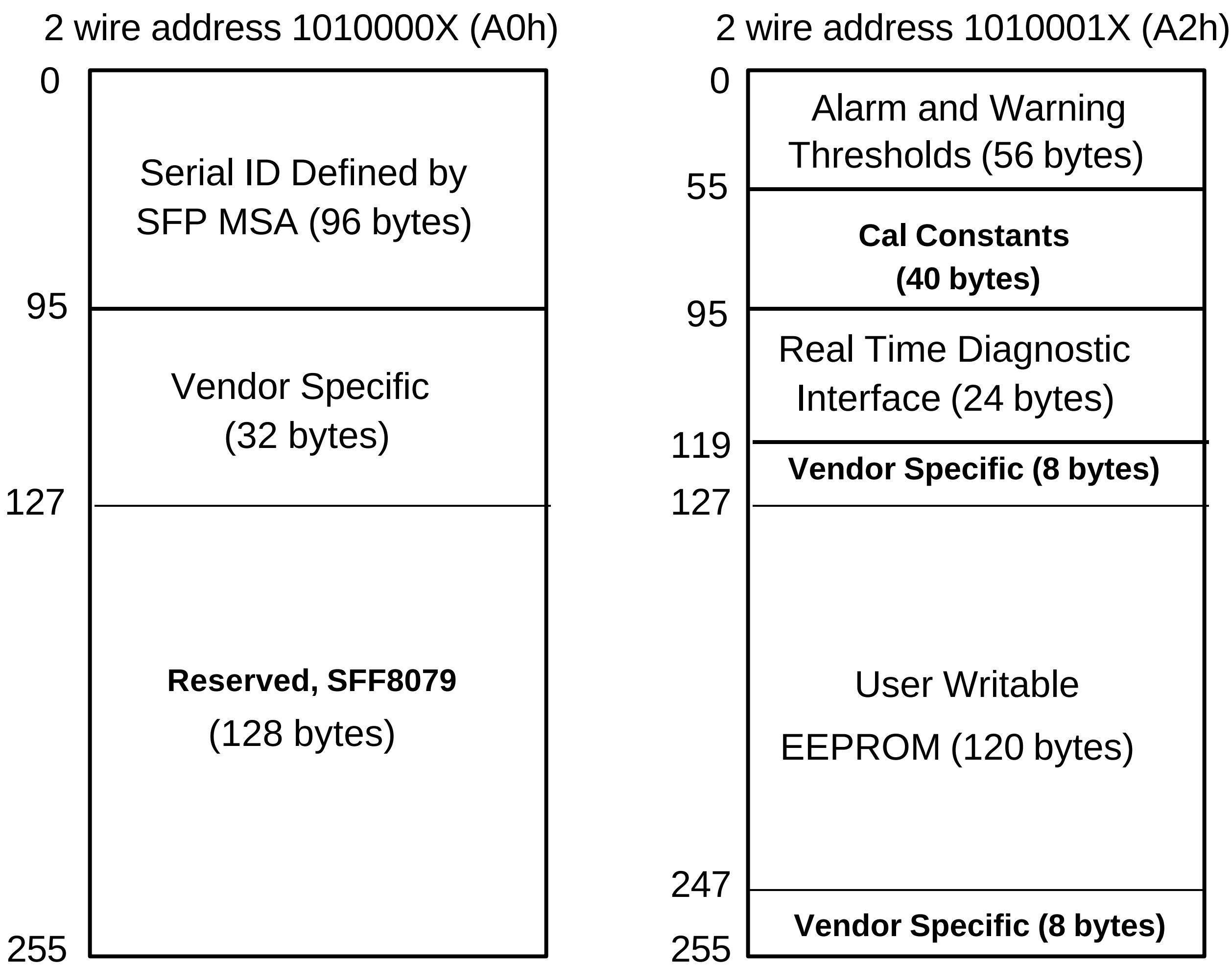
Overview

The enhanced digital diagnostic interface is a superset of the MOD_DEF interface defined in the SFP MSA document dated September 14, 2000. The 2 wire interface pin definitions, hardware, and timing are clearly defined there.

This document describes an extension to the memory map defined in the SFP MSA (See Figure 3.1). The enhanced interface uses the two wire serial bus address 1010001X (A2h) to provide diagnostic information about the module's present operating conditions. The transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture.

Additional parameters are provided to support rate and application selection as specified in SFF-8079 and SFF-8089.

Figure 3.1: Digital Diagnostic Memory Map
Specific Data Field Descriptions



1 **Table 3.1 Serial ID: Data Fields – Address A0**

Data Address	Size (Bytes)	Name of Field	Description of Field
BASE ID FIELDS			
0	1	Identifier	Type of serial transceiver (see table 3.2)
1	1	Ext. Identifier	Extended identifier of type of serial transceiver (see table 3.3)
2	1	Connector	Code for connector type (see table 3.4)
3-10	8	Transceiver	Code for electronic compatibility or optical compatibility (see table 3.5)
11	1	Encoding	Code for serial encoding algorithm (see table 3.6)
12	1	BR, Nominal	Nominal bit rate, units of 100 MBits/sec.
13	1	Reserved	Reserved for SFF-8079
14	1	Length(9μm) - km	Link length supported for 9/125 μm fiber, units of km
15	1	Length (9μm)	Link length supported for 9/125 μm fiber, units of 100 m
16	1	Length (50μm)	Link length supported for 50/125 μm fiber, units of 10 m
17	1	Length (62.5μm)	Link length supported for 62.5/125 μm fiber, units of 10 m
18	1	Length (Copper)	Link length supported for copper, units of meters
19	1	Reserved	
20-35	16	Vendor name	SFP vendor name (ASCII)
36	1	Reserved	
37-39	3	Vendor OUI	SFP vendor IEEE company ID
40-55	16	Vendor PN	Part number provided by SFP vendor (ASCII)
56-59	4	Vendor rev	Revision level for part number provided by vendor (ASCII)
60-61	2	Wavelength	Laser wavelength
62	1	Reserved	
63	1	CC_BASE	Check code for Base ID Fields (addresses 0 to 62)
EXTENDED ID FIELDS			
64-65	2	Options	Indicates which optional transceiver signals are implemented (see table 3.7)
66	1	BR, max	Upper bit rate margin, units of %
67	1	BR, min	Lower bit rate margin, units of %
68-83	16	Vendor SN	Serial number provided by vendor (ASCII)
84-91	8	Date code	Vendor’s manufacturing date code (see table 3.8)
92	1	Diagnostic Monitoring Type	Indicates which type of diagnostic monitoring is implemented (if any) in the transceiver (see Table 3.9)
93	1	Enhanced Options	Indicates which optional enhanced features are implemented (if any) in the transceiver (see Table 3.10)
94	1	SFF-8472 Compliance	Indicates which revision of SFF-8472 the transceiver complies with. (see table 3.12)
95	1	CC_EXT	Check code for the Extended ID Fields (addresses 64 to 94)
VENDOR SPECIFIC ID FIELDS			
96-127	32	Vendor Specific	Vendor Specific EEPROM
128-255	128	Reserved	Reserved for SFF8079.

Identifier

The identifier value specifies the physical device described by the serial information. This value shall be included in the serial data. The defined identifier values are shown in table 3.2.

TABLE 3.2: Identifier values

Value	Description of physical device
00h	Unknown or unspecified
01h	GBIC
02h	Module/connector soldered to motherboard
03h	SFP
04-7Fh	Reserved
80-FFh	Vendor specific

Extended Identifier

The extended identifier value provides additional information about the transceiver.

The field should be set to 04h for all SFP modules indicating serial ID module definition.

In many cases, a GBIC elects to use MOD_DEF 4 to make additional information about the GBIC available, even though the GBIC is actually compliant with one of the 6 other MOD_DEF values defined for GBICs. The extended identifier allows the GBIC to explicitly specify such compliance without requiring the MOD_DEF value to be inferred from the other information provided. The defined extended identifier values are shown in table 3.3.

TABLE 3.3: Extended identifier values

Value	Description of connector
00h	GBIC definition is not specified or the GBIC definition is not compliant with a defined MOD_DEF. See product specification for details.
01h	GBIC is compliant with MOD_DEF 1
02h	GBIC is compliant with MOD_DEF 2
03h	GBIC is compliant with MOD_DEF 3
04h	GBIC/SFP function is defined by serial ID only
05h	GBIC is compliant with MOD_DEF 5
06h	GBIC is compliant with MOD_DEF 6
07h	GBIC is compliant with MOD_DEF 7
08-FFh	Reserved

Connector

The Connector value indicates the external connector provided on the interface. This value shall be included in the serial data. The defined connector values are shown in table 3.4. Note that 01h – 05h are not SFP compatible, and are included for compatibility with GBIC standards.

TABLE 3.4: Connector values

Value	Description of connector
00h	Unknown or unspecified
01h	SC
02h	Fibre Channel Style 1 copper connector
03h	Fibre Channel Style 2 copper connector
04h	BNC/TNC
05h	Fibre Channel coaxial headers
06h	FiberJack
07h	LC
08h	MT-RJ
09h	MU
0Ah	SG
0Bh	Optical pigtail
0C-1Fh	Reserved
20h	HSSDC II
21h	Copper Pigtail
22h-7Fh	Reserved
80-FFh	Vendor specific

Transceiver

The following bit significant indicators define the electronic or optical interfaces that are supported by the transceiver. At least one bit shall be set in this field. For Fibre Channel transceivers, the Fibre Channel speed, transmission media, transmitter technology, and distance capability shall all be indicated. SONET compliance codes are completed by the contents of table 3.5a. Ethernet compliance codes are completed by the contents of table 3.5b.

Table 3.5: Transceiver codes

Data Addr	Bit [1]	Description of transceiver	Data Addr	Bit [1]	Description of transceiver
Infiniband Compliance Codes			**Fibre Channel link length**		
3	4-7	Reserved	7	7	very long distance (V)
3	3	1X SX	7	6	short distance (S)
3	2	1X LX	7	5	intermediate distance (I)
3	1	1X Copper Active	7	4	long distance (L)
3	0	1X Copper Passive	**Fibre Channel transmitter technology**		
			7	3-2	Reserved
ESCON Compliance Codes			7	1	Longwave laser (LC)
4	7	ESCON MMF, 1310nm LED	7	0	Electrical inter-enclosure (EL)
4	6	ESCON SMF, 1310nm Laser	8	7	Electrical intra-enclosure (EL)
SONET Compliance Codes			8	6	Shortwave laser w/o OFC (SN)
4	5	Reserved	8	5	Shortwave laser w/OFC (SL)
4	4	SONET reach specifier bit 1	8	4	Longwave laser (LL)
4	3	SONET reach specifier bit 2	8	3	Copper Active
4	2	OC-48, long reach [2]	8	2	Copper Passive
4	1	OC-48, intermediate reach [2]	8	0-1	Reserved
4	0	OC-48, short reach	**Fibre Channel transmission media**		
5	7	Reserved	9	7	Twin Axial Pair (TW)
5	6	OC-12, single mode, long reach [2]	9	6	Shielded Twisted Pair (TP)
5	5	OC-12, single mode, inter. reach [2]	9	5	Miniature Coax (MI)
5	4	OC-12, short reach [2]	9	4	Video Coax (TV)
5	3	Reserved	9	3	Multi-Mode, 62.5um (M6)
5	2	OC-3, single mode, long reach [2]	9	2	Multi-Mode, 50um (M5)
5	1	OC-3, single mode, inter. reach [2]	9	1	Reserved
5	0	OC-3, short reach [2]	9	0	Single Mode (SM)
Ethernet Compliance Codes			**Fibre Channel speed**		
6	7	BASE-PX [3]	10	7-5	Reserved
6	6	BASE-BX10 [3]	10	4	400 MBytes/sec
6	5	100BASE-FX	10	3	Reserved
6	4	100BASE-LX/LX10	10	2	200 MBytes/sec
6	3	1000BASE-T	10	1	Reserved
6	2	1000BASE-CX	10	0	100 MBytes/sec
6	1	1000BASE-LX [3]			
6	0	1000BASE-SX			

[1] Bit 7 is the high order bit and is transmitted first in each byte.
[2] SONET compliance codes require the use of reach specifier bits 3 and 4 in table 3.5a to completely specify transceiver capabilities.
[3] Ethernet LX, PX and BX compliance codes require the use of the Bit Rate, Nominal value (byte 12), link length values for single mode and two types of multi-mode fiber (Bytes 14-17) and wavelength value for the laser (Bytes 60&61) as specified in Table 3.1 to completely specify transceiver capabilities. See Table 3.5b for the proper values for these parameters.

The SONET compliance code bits allow the host to determine with which specifications a SONET transceiver complies. For each bit rate defined in Table 3.5 (OC-3, OC-12, OC-48), SONET specifies short reach (SR), intermediate reach (IR), and long reach (LR) requirements. For each of the three bit rates, a single short reach (SR) specification is defined. Two variations of intermediate reach (IR-1, IR-2) and three variations of long reach (LR-1, LR-2, and LR-3) are also defined for each bit rate. Byte 4, bits 0-2, and byte 5, bits 0-7 allow the user to determine which of the three reaches has been implemented – short, intermediate, or long. Two additional bits (byte 4, bits 3-4) are necessary to discriminate between different intermediate or long reach variations. These codes are defined in Table 3.5a.

Table 3.5a: SONET Compliance Specifiers

Speed	Reach	Specifier bit 1 (Byte 4 bit 4)	Specifier bit 2 (Byte 4 bit 3)	Description
OC 3/OC 12/OC 48	Short	0	0	SONET SR compliant [1]
OC 3/OC 12/OC 48	Short	1	0	SONET SR-1 compliant [2]
OC 3/OC 12/OC 48	Intermediate	1	0	SONET IR-1 compliant
OC 3/OC 12/OC 48	Intermediate	0	1	SONET IR-2 compliant
OC 3/OC 12/OC 48	Long	1	0	SONET LR-1 compliant
OC 3/OC 12/OC 48	Long	0	1	SONET LR-2 compliant
OC 3/OC 12/OC 48	Long	1	1	SONET LR-3 compliant

[1] OC 3/OC 12 SR is multi-mode based short reach
[2] OC 3/OC 12 SR-1 is single-mode based short reach

As indicated in note 3 of table 3.5, certain Ethernet transceiver types require additional information to fully qualify the transmitter type. This information is contained in the Bit Rate, Nominal value specified in byte 12, the four link length values specified in bytes 14-17, and the Wavelength value for the laser specified in bytes 60 and 61 of Table 3.1. Table 3.5b specifies the values for most Ethernet transceiver types.

Table 3.5b: Ethernet Transceiver Examples

IEEE 802.3 Clause	Transceiver Type	Rate and Distance Specifiers					Wavelength Specifier	Transceiver Description	Number of fibers
		Byte 12	Byte 14	Byte 15	Byte 16	Byte 17	Bytes 60/61		
58	100BASE-LX10	01h	0Ah	64h	00h	00h	051Eh	100 Mb 10km SM 1310nm	2
58	100BASE-BX10-D	01h	0Ah	64h	00h	00h	060Eh	100 Mb 10km SM 1550nm downstream TX	1
58	100BASE-BX10-U	01h	0Ah	64h	00h	00h	051Eh	100 Mb 10km SM 1310nm upstream TX	1
59	1000BASE-BX10-D	0Dh	0Ah	64h	00h	00h	05D2h	1000 Mb 10km SM 1490nm downstream TX	1
59	1000BASE-BX10-U	0Dh	0Ah	64h	00h	00h	051Eh	1000 Mb 10km SM 1310nm upstream TX	1
59	1000BASE-LX	0Dh	05h	32h	37h	37h	051Eh	1000 Mb 5km SM 1310nm	2
59	1000BASE-LX10	0Dh	0Ah	64h	00h	00h	051Eh	1000 Mb 10km SM 1310nm	2
60	1000BASE-PX10-U	0Dh	0Ah	64h	00h	00h	051Eh	1000 Mb 10km SM 1310nm upstream TX	1
60	1000BASE-PX10-D	0Dh	0Ah	64h	00h	00h	05D2h	1000 Mb 10km SM 1490nm downstream TX	1
60	1000BASE-PX20-U	0Dh	14h	C8h	00h	00h	051Eh	1000 Mb 20km SM 1310nm upstream TX	1
60	1000BASE-PX20-D	0Dh	14h	C8h	00h	00h	05D2h	1000 Mb 20km SM 1490nm downstream TX	1

Encoding

The encoding value indicates the serial encoding mechanism that is the nominal design target of the particular transceiver. The value shall be contained in the serial data. The defined encoding values are shown in table 3.6.

Table 3.6: Encoding codes

code	Description of encoding mechanism
00h	Unspecified
01h	8B10B
02h	4B5B
03h	NRZ
04h	Manchester
05h	SONET Scrambled
06h -FFh	Reserved

BR, nominal

The nominal bit rate (BR, nominal) is specified in units of 100 Megabits per second, rounded off to the nearest 100 Megabits per second. The bit rate includes those bits necessary to encode and delimit the signal as well as those bits carrying data information. A value of 0 indicates that the bit rate is not specified and must be determined from the transceiver technology. The actual information transfer rate will depend on the encoding of the data, as defined by the encoding value.

Length (9m)-km

Addition to EEPROM data from original GBIC definition. This value specifies the link length that is supported by the transceiver while operating in compliance with the applicable standards using single mode fiber. The value is in units of kilometers. A value of 255 means that the transceiver supports a link length greater than 254 km. A value of zero means that the transceiver does not support single mode fiber or that the length information must be determined from the transceiver technology.

Length (9m)

This value specifies the link length that is supported by the transceiver while operating in compliance with the applicable standards using single mode fiber. The value is in units of 100 meters. A value of 255 means that the transceiver supports a link length greater than 25.4 km. A value of zero means that the transceiver does not support single mode fiber or that the length information must be determined from the transceiver technology.

Length (50m)

This value specifies the link length that is supported by the transceiver while operating in compliance with the applicable standards using 50 micron multi-mode fiber. The value is in units of 10 meters. A value of 255 means that the transceiver supports a link length greater than 2.54 km. A value of zero means that the transceiver does not support 50 micron multi-mode fiber or that the length information must be determined from the transceiver technology.

Length (62.5m)

This value specifies the link length that is supported by the transceiver while operating in compliance with the applicable standards using 62.5 micron multi-mode fiber. The value is in units of 10 meters. A value of 255 means that the transceiver supports a link length greater than 2.54 km. A value of zero means that the transceiver does not 62.5 micron multi-mode fiber or that the length information must determined from the transceiver technology. It is common for the transceiver to support both 50 micron and 62.5 micron fiber.

Length (Copper)

This value specifies the minimum link length that is supported by the transceiver while operating in compliance with the applicable standards using copper cable. The value is in units of 1 meter. A value of 255 means that the transceiver supports a link length greater than 254 meters. A value of zero means that the transceiver does not support copper cables or that the length information must be determined from the transceiver technology. Further information about the cable design, equalization, and connectors is usually required to guarantee meeting a particular length requirement.

Vendor name

The vendor name is a 16 character field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h). The vendor name shall be the full name of the corporation, a commonly accepted abbreviation of the name of the corporation, the SCSI company code for the corporation, or the stock exchange code for the corporation. At least one of the vendor name or the vendor OUI fields shall contain valid serial data.

Vendor OUI

The vendor organizationally unique identifier field (vendor OUI) is a 3-byte field that contains the IEEE Company Identifier for the vendor. A value of all zero in the 3-byte field indicates that the Vendor OUI is unspecified.

Vendor PN

The vendor part number (vendor PN) is a 16-byte field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the vendor part number or product name. A value of all zero in the 16-byte field indicates that the vendor PN is unspecified.

Vendor Rev

The vendor revision number (vendor rev) is a 4-byte field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the vendor's product revision number. A value of all zero in the 4-byte field indicates that the vendor PN is unspecified.

Laser Wavelength

Nominal transmitter output wavelength at room temperature. 16 bit value with byte 60 as high order byte and byte 61 as low order byte. The laser wavelength is equal to the the 16 bit integer value in nm. This field allows the user to read the laser wavelength directly, so it is not necessary to infer it from the transceiver "Code for Electronic Compatibility" (bytes 3 – 10). This also allows specification of wavelengths not covered in bytes 3 – 10, such as those used in coarse WDM systems.

CC_BASE

The check code is a one byte code that can be used to verify that the first 64 bytes of serial information in the SFP is valid. The check code shall be the low order 8 bits of the sum of the contents of all the bytes from byte 0 to byte 62, inclusive.

Options

The bits in the option field shall specify the options implemented in the transceiver as described in table 3.7.

Table 3.7: Option values

data address	bit	Description of option
64	7-0	Reserved
65	7-6	Reserved
65	5	RATE_SELECT is implemented NOTE: Lack of implemention does not indicate lack of simultaneous compliance with multiple standard rates. Compliance with particular standards should be determined from Transceiver Code Section (Table 3.5)
65	4	TX_DISABLE is implemented and disables the serial output.
65	3	TX_FAULT signal implemented. (See SFP MSA)
65	2	Loss of Signal implemented, signal inverted from standard definition in SFP MSA. NOTE: This is not standard SFP/GBIC behavior and should be avoided, since non-interoperable behavior results.
65	1	Loss of Signal implemented, signal as defined in SFP MSA
65	0	Reserved

BR, max

The upper bit rate limit at which the transceiver will still meet its specifications (BR, max) is specified in units of 1% above the nominal bit rate. A value of zero indicates that this field is not specified.

BR, min

The lower bit rate limit at which the transceiver will still meet its specifications (BR, min) is specified in units of 1% below the nominal bit rate. A value of zero indicates that this field is not specified.

Vendor SN

The vendor serial number (vendor SN) is a 16 character field that contains ASCII characters, left-aligned and padded on the right with ASCII spaces (20h), defining the vendor's serial number for the transceiver. A value of all zero in the 16-byte field indicates that the vendor PN is unspecified.

Date Code

The date code is an 8-byte field that contains the vendor's date code in ASCII characters. The date code is mandatory. The date code shall be in the format specified by table 3.8.

Table 3.8: Date Code

Data Address	Description of field
84-85	ASCII code, two low order digits of year. (00 = 2000).
86-87	ASCII code, digits of month (01 = Jan through 12 = Dec)
88-89	ASCII code, day of month (01 - 31)
90-91	ASCII code, vendor specific lot code, may be blank

Diagnostic Monitoring Type

"Diagnostic Monitoring Type" is a 1 byte field with 8 single bit indicators describing how diagnostic monitoring is implemented in the particular transceiver.

Note that if bit 6, address 92 is set indicating that digital diagnostic monitoring has been implemented, received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring must all be implemented. Additionally, alarm and warning thresholds must be written as specified in this document at locations 00 – 55 on 2 wire serial address 1010001X (A2h) (see Table 3.9).

Two calibration options are possible if bit 6 has been set indicating that digital diagnostic monitoring has been implemented. If bit 5, "Internally calibrated", is set, the transceiver directly reports calibrated values in units of current, power etc. If bit 4, "Externally calibrated", is set, the reported values are A/D counts which must be converted to real world units using calibration values read using 2 wire serial address 1010001X (A2h) from bytes 55 - 95. See "Diagnostics" section for details.

Bit 3 indicates whether the received power measurement represents average input optical power or OMA. If the bit is set, average power is monitored. If it is not, OMA is monitored.

Addressing Modes

Bit 2 indicates whether or not it is necessary for the host to perform an address change sequence before accessing information at 2-wire serial address A2h. If this bit is not set, the host may simply read from either address, A0h or A2h, by using that value in the address byte during the 2-wire communication sequence. If the bit is set, the following sequence must be executed prior to accessing information at address A2h. Once A2h has been accessed, it will be necessary to execute the address change sequence again prior to reading from A0h. The address change sequence is defined as the following steps on the 2 wire serial interface:

1) Host controller performs a Start condition, followed by a slave address of 0b00000000.
-- Note that the R/W bit of this address indicates transfer from host to device ('0'b).
2) Device responds with Ack
3) Host controller transfers 0b00000100 (04h) as the next 8 bits of data
-- This value indicates that the device is to change its address
4) Device responds with Ack
5) Host controller transfers one of the following values as the next 8 bits of data:
--0bXXXXXX00 – specifies Serial ID memory page
--0bXXXXXX10 – specifies Digital Diagnostic memory page
6) Device responds with Ack
7) Host controller performs a Stop condition
8) Device changes address that it responds to, based on the Step 5 byte value above:
--0bXXXXXX00 – address becomes 0b1010000X (A0h)
--0bXXXXXX10 – address becomes 0b1010001X (A2h)

Table 3.9: Diagnostic Monitoring Type

Data Address	Bits	Description
92	7	Reserved for legacy diagnostic implementations. Must be '0' for compilance with this document.
92	6	Digital diagnostic monitoring implemented (described in this document). Must be '1' for compliance with this document.
92	5	Internally Calibrated
92	4	Externally Calibrated
92	3	Received power measurement type 0 = OMA, 1 = Average Power
92	2	Address change required see section above, "addressing modes"
92	1-0	Reserved

Enhanced Options

"Enhanced Options" is a 1 byte field with 8 single bit indicators which describe the optional digital diagnostic features implemented in the transceiver. Since transceivers will not necessarily implement all optional features described in this document, the "Enhanced Options" bit field allows the host system to determine which functions are available over the 2 wire serial bus. A '1' indicates that the particular function is implemented in the transceiver. Bits 3 and 6 of byte 110 (see Table 3.17) allow the user to control the Rate_Select and TX_Disable functions. If these functions are not implemented, the bits remain readable and writable, but the transceiver ignores them.

Note that the "soft" control functions - TX_DISABLE, TX_FAULT, RX_LOS, and RATE_SELECT do not meet the timing requirements specified in the SFP MSA section B3 "Timing Requirements of Control and Status I/O" and the GBIC Specification, revision 5.5, (SFF-8053), section 5.3.1, for their corresponding pins. The soft functions allow a host to poll or set these values over the serial bus as an alternative to monitoring/setting pin values. Timing is vendor specific, but must meet the requirements specified in Table 3.11 below.

Table 3.10: Enhanced Options

Data Address	Bits	Description
93	7	Optional Alarm/warning flags implemented for all monitored quantities (see Table 3.18)
93	6	Optional Soft TX_DISABLE control and monitoring implemented
93	5	Optional Soft TX_FAULT monitoring implemented
93	4	Optional Soft RX_LOS monitoring implemented
93	3	Optional Soft RATE_SELECT control and monitoring implemented
93	2	Optional Application Select control implemented per SFF8079
93	1 and 0	Reserved

Table 3.11: I/O Timing for Soft Control & Status Functions

Parameter	Symbol	Min	Max	Units	Conditions
TX_DISABLE assert time	t_off		100	ms	Time from TX_DISABLE bit set[1] until optical output falls below 10% of nominal
TX_DISABLE deassert time	t_on		100	ms	Time from TX_DISABLE bit cleared[1] until optical output rises above 90% of nominal
Time to initialize, including reset of TX_FAULT	t_init		300	ms	Time from power on or negation of TX_FAULT using TX_DISABLE until transmitter output is stable[2].
TX_FAULT assert time	t_fault		100	ms	Time from fault to TX_FAULT bit set.
LOS assert time	t_loss_on		100	ms	Time from LOS state to RX_LOS bit set
LOS deassert time	t_loss_off		100	ms	Time from non-LOS state to RX_LOS bit cleared
Rate select change time	T_rate_sel		100	ms	Time from change of state of Rate Select bit[1] until receiver bandwidth is in conformance with appropriate specification
Serial ID clock rate	f_serial_clock		100	kHz	n/a
Analog parameter data ready	t_data		1000	ms	From power on to data ready, bit 0 of byte 110 set
Serial bus hardware ready	t_serial		300	ms	Time from power on until module is ready for data transmission over the serial bus.

[1] measured from falling clock edge after stop bit of write transaction.
[2] See Gigabit Interface Converter (GBIC). SFF-0053, rev. 5.5, September 27, 2000

SFF-8472 Compliance

Byte 94 contains an unsigned integer that indicates which feature set(s) are implemented in the transceiver.

Table 3.12: SFF-8472 Compliance

Data Address	Value	Interpretation
94	00h	Digital diagnostic functionality not included or undefined.
94	01h	Includes functionality described in Rev 9.3 of SFF-8472.
94	02h	Includes functionality described in Rev 9.4 of SFF-8472
94	03h - FFh	Reserved

CC_EXT

The check code is a one byte code that can be used to verify that the first 32 bytes of extended serial information in the SFP is valid. The check code shall be the low order 8 bits of the sum of the contents of all the bytes from byte 64 to byte 94, inclusive.

Diagnostics

2 wire serial bus address 1010001X (A2h) is used to access measurements of transceiver temperature, internally measured supply voltage, TX bias current, TX output power, received optical power, and two additional quantities to be defined in the future.

The values are interpreted differently depending upon the option bits set at address 92. If bit 5 "internally calibrated" is set, the values are calibrated absolute measurements, which should be interpreted according to the section "Internal Calibration" below. If bit 4 "externally calibrated" is set, the values are A/D counts, which are converted into real units per the subsequent section titled "External Calibration".

Measured parameters are reported in 16 bit data fields, i.e., two concatenated bytes. The 16 bit data fields allow for wide dynamic range. This is not intended to imply that a 16 bit A/D system is recommended or required in order to achieve the accuracy goals stated below. The width of the data field should not be taken to imply a given level of precision. It is conceivable that the accuracy goals herein can be achieved by a system having less than 16 bits of resolution. It is recommended that any low-order data bits beyond the system's specified accuracy be fixed at zero. Overall system accuracy and precision will be vendor dependent.

To guarantee coherency of the diagnostic monitoring data, the host is required to retrieve any multi-byte fields from the diagnostic monitoring data structure (IE: Rx Power MSB - byte 104 in A2h, Rx Power LSB - byte 105 in A2h) by the use of a single two-byte read sequence across the serial interface.

The transceiver is required to insure that any multi-byte fields which are updated with diagnostic monitoring data (e.g. Rx Power MSB - byte 104 in A2h, Rx Power LSB - byte 105 in A2h) must have this update done in a fashion which guarantees coherency and consistency of the data. In other words, the update of a multi-byte field by the transceiver must not occur such that a partially updated multi-byte field can be transferred to the host. Also, the transceiver shall not update a multi-byte field within the structure during the transfer of that multi-byte field to the host, such that partially updated data would be transferred to the host.

Accuracy requirements specified below shall apply to the operating signal range specified in the relevant standard. The manufacturer's specification should be consulted for more detail on the conditions under which the accuracy requirements are met.

<u>Internal Calibration</u>

Measurements are calibrated over vendor specified operating temperature and voltage and should be interpreted as defined below. Alarm and warning threshold values should be interpreted in the same manner as real time 16 bit data.

1) Internally measured transceiver temperature. Represented as a 16 bit signed twos complement value in increments of 1/256 degrees Celsius, yielding a total range of –128C to +128C. Temperature accuracy is vendor specific but must be better than ±3 degrees Celsius over specified operating temperature and voltage. Please see vendor specification for details on location of temperature sensor. The temperature in degrees Celsius is given by the signed twos complement value with LSB equal to 1/256 C. See Tables 3.13 and 3.14 below for examples of temperature format.

2) Internally measured transceiver supply voltage. Represented as a 16 bit unsigned integer with the voltage defined as the full 16 bit value (0 – 65535) with LSB equal to 100 µVolt, yielding a total range of 0 to +6.55 Volts. Practical considerations to be defined by transceiver manufacturer will tend to limit the actual bounds of the supply voltage measurement. Accuracy is vendor specific but must be better than ±3% of the manufacturer's nominal value over specified operating temperature and voltage. Note that in some transceivers, transmitter supply voltage and receiver supply voltage are isolated. In that case, only one supply is monitored. Refer to the device specification for more detail.

3) Measured TX bias current in µA. Represented as a 16 bit unsigned integer with the current defined as the full 16 bit value (0 – 65535) with LSB equal to 2 µA, yielding a total range of 0 to 131 mA. Accuracy is vendor specific but must be better than ±10% of the manufacturer's nominal value over specified operating temperature and voltage.

4) Measured TX output power in mW. Represented as a 16 bit unsigned integer with the power defined as the full 16 bit value (0 – 65535) with LSB equal to 0.1 µW, yielding a total range of 0 to 6.5535 mW (~ -40 to +8.2 dBm). Data is assumed to be based on measurement of laser monitor photodiode current. It is factory calibrated to absolute units using the most representative fiber output type. Accuracy is vendor specific but must be better than ±3dB over specified temperature and voltage. Data is not valid when the transmitter is disabled.

5) Measured RX received optical power in mW. Value can represent either average received power or OMA depending upon how bit 3 of byte 92 (A0h) is set. Represented as a 16 bit unsigned integer with the power defined as the full 16 bit value (0 – 65535) with LSB equal to 0.1 µW, yielding a total range of 0 to 6.5535 mW (~ -40 to +8.2 dBm). Absolute accuracy is dependent upon the exact optical wavelength. For the vendor specified wavelength, accuracy shall be better than ±3dB over specified temperature and voltage. This accuracy shall be maintained for input power levels up to the lesser of maximum transmitted or maximum received optical power per the appropriate standard. It shall be maintained down to the minimum transmitted power minus cable plant loss (insertion loss or passive loss)

per the appropriate standard. Absolute accuracy beyond this minimum required received input optical power range is vendor specific.

Tables 3.13 and 3.14 below illustrate the 16 bit signed twos complement format used for temperature reporting. The most significant bit (D7) represents the sign, which is zero for positive temperatures and one for negative temperatures.

Table 3.13: Bit weights (°C) for temperature reporting registers

Most Significant Byte (byte 96)								Least Significant Byte (byte 97)							
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
SIGN	64	32	16	8	4	2	1	1/2	1/4	1/8	1/16	1/32	1/64	1/128	1/256

Table 3.14: Digital temperature format

Temperature		BINARY		HEXADECIMAL	
DECIMAL	FRACTION	HIGH BYTE	LOW BYTE	HIGH BYTE	LOW BYTE
+127.996	+127 255/256	01111111	11111111	7F	FF
+125.000	+125	01111101	00000000	7D	00
+25.000	+25	00011001	00000000	19	00
+1.004	+1 1/256	00000001	00000001	01	01
+1.000	+1	00000001	00000000	01	00
+0.996	+255/256	00000000	11111111	00	FF
+0.004	+1/256	00000000	00000001	00	01
0.000	0	00000000	00000000	00	00
-0.004	-1/256	11111111	11111111	FF	FF
-1.000	-1	11111111	00000000	FF	00
-25.000	-25	11100111	00000000	E7	00
-40.000	-40	11011000	00000000	D8	00
-127.996	-127 255/256	10000000	00000001	80	01
-128.000	-128	10000000	00000000	80	00

External Calibration

Measurements are raw A/D values and must be converted to real world units using calibration constants stored in EEPROM locations 56 – 95 at 2 wire serial bus address A2h. Calibration is valid over vendor specified operating temperature and voltage. Alarm and warning threshold values should be interpreted in the same manner as real time 16 bit data.

After calibration per the equations given below for each variable, the results are consistent with the accuracy and resolution goals for internally calibrated devices.

1) Internally measured transceiver temperature. Module temperature, T, is given by the following equation: $T(C) = T_{slope} * T_{AD}$ (16 bit signed twos complement value) + T_{offset}. The result is in units of 1/256C, yielding a total range of –128C to +128C. See Table 3.16 for locations of T_{SLOPE} and T_{OFFSET}. Temperature accuracy is vendor specific but must be better than ±3 degrees Celsius over specified operating temperature and voltage. Please see vendor specification sheet for details on location of temperature sensor. Tables 3.13 and 3.14 above give examples of the 16 bit signed twos complement temperature format.

2) Internally measured supply voltage. Module internal supply voltage, V, is given in microvolts by the following equation: $V(\mu V) = V_{SLOPE} * V_{AD}$ (16 bit unsigned integer) + V_{OFFSET}. The result is in units of 100µV, yielding a total range of 0 – 6.55V. See Table 3.16 for locations of V_{SLOPE} and V_{OFFSET}. Accuracy is vendor specific but must be better than ±3% of the manufacturer's nominal value over specified operating temperature and voltage. Note that in some transceivers, transmitter supply voltage and receiver supply voltage are isolated. In that case, only one supply is monitored. Refer to the manufacturer's specification for more detail.

3) Measured transmitter laser bias current. Module laser bias current, I, is given in microamps by the following equation: $I(\mu A) = I_{SLOPE} * I_{AD}$ (16 bit unsigned integer) + I_{OFFSET}. This result is in units of 2 µA, yielding a total range of 0 to 131 mA. See Table 3.16 for locations of I_{SLOPE} and I_{OFFSET}. Accuracy is vendor specific but must be better than ±10% of the manufacturer's nominal value over specified operating temperature and voltage.

4) Measured coupled TX output power. Module transmitter coupled output power, TX_PWR, is given in µW by the following equation: $TX\_PWR (\mu W) = TX\_PWR_{SLOPE} * TX\_PWR_{AD}$ (16 bit unsigned integer) + TX_PWR_{OFFSET}. This result is in units of 0.1µW yielding a total range of 0 – 6.5mW. See Table 3.16 for locations of TX_PWR_{SLOPE} and TX_PWR_{OFFSET}. Accuracy is vendor specific but must be better than ±3dB over specified operating temperature and voltage. Data is assumed to be based on measurement of a laser monitor photodiode current. It is factory calibrated to absolute units using the most representative fiber output type. Data is not valid when the transmitter is disabled.

5) Measured received optical power. Received power, RX_PWR, is given in µW by the following equation:

$Rx\_PWR\ (\mu W) = Rx\_PWR(4) * Rx\_PWR_{AD}^4$ (16 bit unsigned integer) + $Rx\_PWR(3)*Rx\_PWR_{AD}^3$(16 bit unsigned integer) + $Rx\_PWR(2)*Rx\_PWR_{AD}^2$(16 bit unsigned integer) + $Rx\_PWR(1) *Rx\_PWR_{AD}$ (16 bit unsigned integer) + $Rx\_PWR(0)$

The result is in units of 0.1µW yielding a total range of 0 – 6.5mW. See Table 3.16 for locations of Rx_PWR(4-0). Absolute accuracy is dependent upon the exact optical wavelength. For the vendor specified wavelength, accuracy shall be better than ±3dB over specified temperature and voltage. This accuracy shall be maintained for input power levels up to the lesser of maximum transmitted or maximum received optical power per the appropriate standard. It shall be maintained down to the minimum transmitted power minus cable plant loss (insertion loss or passive loss) per the appropriate standard. Absolute accuracy beyond this minimum required received input optical power range is vendor specific.

Alarm and Warning Thresholds

Each A/D quantity has a corresponding high alarm, low alarm, high warning and low warning threshold. These factory preset values allow the user to determine when a particular value is outside of "normal" limits as determined by the transceiver manufacturer. It is assumed that these values will vary with different technologies and different implementations. When external calibration is used, data may be compared to alarm and warning threshold values before or after calibration by the host. Comparison can be done directly before calibration. If comparison is to be done after calibration, calibration must first be applied to both data and threshold values.

The values reported in the alarm and warning thresholds area (see below) may be temperature compensated or otherwise adjusted when setting warning and/or alarm flags. Any threshold compensation or adjustment is vendor specific and optional. See vendor's data sheet for use of alarm and warning thresholds.

Table 3.15: Alarm and Warning Thresholds (2-Wire Address A2h)

Address	# Bytes	Name	Description
00-01	2	Temp High Alarm	MSB at low address
02-03	2	Temp Low Alarm	MSB at low address
04-05	2	Temp High Warning	MSB at low address
06-07	2	Temp Low Warning	MSB at low address
08-09	2	Voltage High Alarm	MSB at low address
10-11	2	Voltage Low Alarm	MSB at low address
12-13	2	Voltage High Warning	MSB at low address
14-15	2	Voltage Low Warning	MSB at low address
16-17	2	Bias High Alarm	MSB at low address
18-19	2	Bias Low Alarm	MSB at low address
20-21	2	Bias High Warning	MSB at low address
22-23	2	Bias Low Warning	MSB at low address
24-25	2	TX Power High Alarm	MSB at low address
26-27	2	TX Power Low Alarm	MSB at low address
28-29	2	TX Power High Warning	MSB at low address
30-31	2	TX Power Low Warning	MSB at low address
32-33	2	RX Power High Alarm	MSB at low address
34-35	2	RX Power Low Alarm	MSB at low address
36-37	2	RX Power High Warning	MSB at low address
38-39	2	RX Power Low Warning	MSB at low address
40-55	16	Reserved	Reserved for future monitored quantities

Calibration Constants

TABLE 3.16: Calibration constants for External Calibration Option (2 Wire Address A2h)

Address	# Bytes	Name	Description
56-59	4	Rx_PWR(4)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 56 is MSB. Bit 0 of byte 59 is LSB. Rx_PWR(4) should be set to zero for “internally calibrated” devices.
60-63	4	Rx_PWR(3)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 60 is MSB. Bit 0 of byte 63 is LSB. Rx_PWR(3) should be set to zero for “internally calibrated” devices.
64-67	4	Rx_PWR(2)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 64 is MSB, bit 0 of byte 67 is LSB. Rx_PWR(2) should be set to zero for “internally calibrated” devices.
68-71	4	Rx_PWR(1)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 68 is MSB, bit 0 of byte 71 is LSB. Rx_PWR(1) should be set to 1 for “internally calibrated” devices.
72-75	4	Rx_PWR(0)	Single precision floating point calibration data, Rx optical power. Bit 7 of byte 72 is MSB, bit 0 of byte 75 is LSB. Rx_PWR(0) should be set to zero for “internally calibrated” devices.
76-77	2	Tx_I(Slope)	Fixed decimal (unsigned) calibration data, laser bias current. Bit 7 of byte 76 is MSB, bit 0 of byte 77 is LSB. Tx_I(Slope) should be set to 1 for “internally calibrated” devices.
78-79	2	Tx_I(Offset)	Fixed decimal (signed two’s complement) calibration data, laser bias current. Bit 7 of byte 78 is MSB, bit 0 of byte 79 is LSB. Tx_I(Offset) should be set to zero for “internally calibrated” devices.
80-81	2	Tx_PWR(Slope)	Fixed decimal (unsigned) calibration data, transmitter coupled output power. Bit 7 of byte 80 is MSB, bit 0 of byte 81 is LSB. Tx_PWR(Slope) should be set to 1 for “internally calibrated” devices.
82-83	2	Tx_PWR(Offset)	Fixed decimal (signed two’s complement) calibration data, transmitter coupled output power. Bit 7 of byte 82 is MSB, bit 0 of byte 83 is LSB. Tx_PWR(Offset) should be set to zero for “internally calibrated” devices.
84-85	2	T (Slope)	Fixed decimal (unsigned) calibration data, internal module temperature. Bit 7 of byte 84 is MSB, bit 0 of byte 85 is LSB. T(Slope) should be set to 1 for “internally calibrated” devices.
86-87	2	T (Offset)	Fixed decimal (signed two’s complement) calibration data, internal module temperature. Bit 7 of byte 86 is MSB, bit 0 of byte 87 is LSB. T(Offset) should be set to zero for “internally calibrated” devices.
88-89	2	V (Slope)	Fixed decimal (unsigned) calibration data, internal module supply voltage. Bit 7 of byte 88 is MSB, bit 0 of byte 89 is LSB. V(Slope) should be set to 1 for “internally calibrated” devices.
90-91	2	V (Offset)	Fixed decimal (signed two’s complement) calibration data, internal module supply voltage. Bit 7 of byte 90 is MSB. Bit 0 of byte 91 is LSB. V(Offset) should be set to zero for “internally calibrated” devices.
92-4	3	Reserved	Reserved
95	1	Checksum	Byte 95 contains the low order 8 bits of the sum of bytes 0 – 94.

The slope constants at addresses 76, 80,84, and 88, are unsigned fixed-point binary numbers. The slope will therefore always be positive. The binary point is in between the upper and lower bytes, i.e., between the eight and ninth most significant bits. The most significant byte is the integer portion in the range 0 to +255. The least significant byte represents the fractional portion in the range of 0.00391 (1/256) to 0.9961 (255/256). The smallest real number that can be represented by this format is 0.00391 (1/256); the largest real number that can be represented using this format is 255.9961 (255 + 255/256). Slopes are defined, and conversion formulas found, in the “External Calibration” section. Examples of this format are illustrated below:

Table 3.16a: Unsigned fixed-point binary format for slopes

Decimal Value	Binary Value		Hexadecimal Value	
	MSB	LSB	High Byte	Low Byte
0.0000	00000000	00000000	00	00
0.0039	00000000	00000001	00	01
1.0000	00000001	00000000	01	00
1.0313	00000001	00001000	01	08
1.9961	00000001	11111111	01	FF
2.0000	00000010	00000000	02	00
255.9921	11111111	11111110	FF	FE
255.9961	11111111	11111111	FF	FF

The calibration offsets are 16-bit signed twos complement binary numbers. The offsets are defined by the formulas in the “External Calibration” section. The least significant bit represents the same units as described above under “Internal Calibration” for the corresponding analog parameter, e.g., 2µA for bias current, 0.1µW for optical power, etc. The range of possible integer values is from +32767 to -32768. Examples of this format are shown below.

Table 3.16b: Format for offsets

Decimal Value	Binary Value		Hexadecimal Value	
	High Byte	Low Byte	High Byte	Low Byte
+32767	01111111	1111111	7F	FF
+3	00000000	00000011	00	03
+2	00000000	00000010	00	02
+1	00000000	00000001	00	01
0	00000000	00000000	00	00
-1	11111111	11111111	FF	FF
-2	11111111	11111110	FF	FE
-3	11111111	11111101	FF	FD
-32768	10000000	00000000	80	00

External calibration of received optical power makes use of single-precision floating-point numbers as defined by *IEEE Standard for Binary Floating-Point Arithmetic*, IEEE Std 754-1985. Briefly, this format utilizes four bytes (32 bits) to represent real numbers. The first and most significant bit is the sign bit; the next eight bits indicate an exponent in the range of +126 to –127; the remaining 23 bits represent the mantissa. The 32 bits are therefore arranged as in Table 3.16c below.

Table 3.16c: IEEE-754 Single-Precision Floating Point Number Format

<table>
<tr><td>FUNCTION</td><td>SIGN</td><td colspan="2">EXPONENT</td><td colspan="3">MANTISSA</td></tr>
<tr><td>BIT</td><td>31</td><td colspan="2">30……………………2
3</td><td colspan="3">22……………………………………………………………0</td></tr>
<tr><td>BYTE</td><td colspan="2">3</td><td colspan="2">2</td><td>1</td><td>0</td></tr>
<tr><td colspan="7">← Most Significant Least
Significant →</td></tr>
</table>

Rx_PWR(4), as an example, is stored as in Table 3.16d.

Table 3.16d: Example of Floating Point Representation

BYTE ADDRESS	CONTENTS	SIGNIFICANCE
56	SEEEEEEE	Most
57	EMMMMMMM	2nd Most
58	MMMMMMMM	2nd Least
59	MMMMMMMM	Least

where S = sign bit; E = exponent bit; M = mantissa bit.

Special cases of the various bit values are reserved to represent indeterminate values such as positive and negative infinity; zero; and “NaN”or not a number. NaN indicates an invalid result. As of this writing, explanations of the IEEE single precision floating point format were posted on the worldwide web at

http://www.psc.edu/general/software/packages/ieee/ieee.html

and

http://research.microsoft.com/~hollasch/cgindex/coding/ieeefloat.html.

The actual IEEE standard is available at www.IEEE.org.

Real Time Diagnostic Registers

TABLE 3.17: A/D Values and Status Bits (2 Wire Address A2h)

Byte	Bit	Name	Description
Converted analog values. Calibrated 16 bit data.			
96	All	Temperature MSB	Internally measured module temperature.
97	All	Temperature LSB	
98	All	Vcc MSB	Internally measured supply voltage in transceiver.
99	All	Vcc LSB	
100	All	TX Bias MSB	Internally measured TX Bias Current.
101	All	TX Bias LSB	
102	All	TX Power MSB	Measured TX output power.
103	All	TX Power LSB	
104	All	RX Power MSB	Measured RX input power.
105	All	RX Power LSB	
106	All	Reserved MSB	Reserved for 1st future definition of digitized analog input
107	All	Reserved LSB	Reserved for 1st future definition of digitized analog input
108	All	Reserved MSB	Reserved for 2nd future definition of digitized analog input
109	All	Reserved LSB	Reserved for 2nd future definition of digitized analog input
Optional Status/Control Bits			
110	7	TX Disable State	Digital state of the TX Disable Input Pin. Updated within 100msec of change on pin.
110	6	Soft TX Disable	Read/write bit that allows software disable of laser. Writing ‘1’ disables laser. Turn on/off time is 100 msec max from acknowledgement of serial byte transmission. This bit is “OR”d with the hard TX_DISABLE pin value. Note, per SFP MSA TX_DISABLE pin is default enabled unless pulled low by hardware. If Soft TX Disable is not implemented, the transceiver ignores the value of this bit. Default power up value is 0.
110	5	Reserved	Reserved for SFF-8079.
110	4	RX Rate Select State	Digital state of the SFP RX Rate Select Input Pin. Updated within 100msec of change on pin.
110	3	Soft RX Rate Select	Read/write bit that allows software RX rate select. Writing ‘1’ selects full bandwidth operation. This bit is “OR’d with the hard RX RATE_SELECT pin value. Enable/disable time is 100msec max from acknowledgement of serial byte transmission. Soft RX rate select does not meet the autonegotiation requirements specified in FC-FS. Default at power up is zero. If Soft RX Rate Select is not implemented, the transceiver ignores the value of this bit.
110	2	TX Fault	Digital state of the TX Fault Output Pin. Updated within 100msec of change on pin.
110	1	LOS	Digital state of the LOS Output Pin. Updated within 100msec of change on pin.
110	0	Data_Ready_Bar	Indicates transceiver has achieved power up and data is ready. Bit remains high until data is ready to be read at which time the device sets the bit low.
111	7-0	Reserved	Reserved for SFF-8079.

The data_ready_bar bit is high during module power up and prior to the first valid A/D reading. Once the first valid A/D reading occurs, the bit is set low until the device is powered down. The bit must be set low within 1 second of power up.

Bytes 112 – 119 contain an optional set of alarm and warning flags. The flags may be latched or non-latched. Implementation is vendor specific, and the vendor's specification sheet should be consulted for details. It is recommended that in either case, detection of an asserted flag bit should be verified by a second read of the flag at least 100msec later. For users who do not wish to set their own threshold values or read the values in locations 0 - 55, the flags alone can be monitored. Two flag types are defined.

1) Alarm flags associated with transceiver temperature, supply voltage, TX bias current, TX output power and received optical power as well as reserved locations for future flags. Alarm flags indicate conditions likely to be associated with an in-operational link and cause for immediate action.

2) Warning flags associated with transceiver temperature, supply voltage, TX bias current, TX output power and received optical power as well as reserved locations for future flags. Warning flags indicate conditions outside the normally guaranteed bounds but not necessarily causes of immediate link failures. Certain warning flags may also be defined by the manufacturer as end-of-life indicators (such as for higher than expected bias currents in a constant power control loop).

Alarm and Warning Flags

Table 3.18: Alarm and Warning Flag Bits (2-Wire Address A2h)

Reserved Optional Alarm and Warning Flag Bits (See Notes 3-6)			
112	7	Temp High Alarm	Set when internal temperature exceeds high alarm level.
112	6	Temp Low Alarm	Set when internal temperature is below low alarm level.
112	5	Vcc High Alarm	Set when internal supply voltage exceeds high alarm level.
112	4	Vcc Low Alarm	Set when internal supply voltage is below low alarm level.
112	3	TX Bias High Alarm	Set when TX Bias current exceeds high alarm level.
112	2	TX Bias Low Alarm	Set when TX Bias current is below low alarm level.
112	1	TX Power High Alarm	Set when TX output power exceeds high alarm level.
112	0	TX Power Low Alarm	Set when TX output power is below low alarm level.
113	7	RX Power High Alarm	Set when Received Power exceeds high alarm level.
113	6	RX Power Low Alarm	Set when Received Power is below low alarm level.
113	5	Reserved Alarm	
113	4	Reserved Alarm	
113	3	Reserved Alarm	
113	2	Reserved Alarm	
113	1	Reserved Alarm	
113	0	Reserved Alarm	
114	All	Reserved	
115	All	Reserved	
116	7	Temp High Warning	Set when internal temperature exceeds high warning level.
116	6	Temp Low Warning	Set when internal temperature is below low warning level.
116	5	Vcc High Warning	Set when internal supply voltage exceeds high warning level.
116	4	Vcc Low Warning	Set when internal supply voltage is below low warning level.
116	3	TX Bias High Warning	Set when TX Bias current exceeds high warning level.
116	2	TX Bias Low Warning	Set when TX Bias current is below low warning level.
116	1	TX Power High Warning	Set when TX output power exceeds high warning level.
116	0	TX Power Low Warning	Set when TX output power is below low warning level.
117	7	RX Power High Warning	Set when Received Power exceeds high warning level.
117	6	RX Power Low Warning	Set when Received Power is below low warning level.
117	5	Reserved Warning	
117	4	Reserved Warning	
117	3	Reserved Warning	
117	2	Reserved Warning	
117	1	Reserved Warning	
117	0	Reserved Warning	
118	All	Reserved	
119	All	Reserved	

Vendor Specific Locations

Bytes 120 – 127 are defined for vendor specific functions.

Table 3.19: Vendor Specific Memory Addresses (2-Wire Address A2h)

Byte	Bit	Name	Description
120-127	All	Vendor Specific	Vendor Specific

User Accessible EEPROM

Table 3.20: User EEPROM (2-Wire Address A2h)

Address	# Bytes	Name	Description
128-247	120	User EEPROM	User writable EEPROM
248-255	8	Vendor Specific	Vendor specific control functions